

The Avellino Event: cultural and demographic effects of the great Bronze Age eruption of Mount Vesuvius

A 4-year NWO-funded archaeological research program starting 1 June 2015

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Vulcanic eruptions, Early Bronze Age, Migrations, Central Italy, Paleoenvironmental studies

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Around 1995 BC, during the Early Bronze Age, a giant eruption of Mount Vesuvius buried a flourishing landscape of villages and fields in the plains to the north and east of the volcano under more than a meter of ash. Inhabitants of Campanian sites such as Nola ('the Bronze Age Pompeii') could barely escape with their lives. Italian archaeological research since the 1980s has conclusively shown that the population of the Campanian plain did not fully recover for several centuries after this so-called 'Avellino Event'.

Oddly, no one has yet wondered where the substantial Early Bronze Age population of Campania could have flown to, and what impacts it would have had there. Given the topography of central-southern Italy, the most likely refuge area will have been to the north, in the coastal zone of what is now South Lazio. Here, two wetland coastal plains – the Fondi basin and the Agro Pontino - could have provided the space and resources to absorb the fleeing population. Long-standing Dutch research programs in these areas have already shown that both have a continuous sedimentary record that covers the period of interest and that, crucially, includes the Avellino volcanic ash as a chronological marker. This means that archaeological and palaeo-ecological observations of the requisite high chronological resolution and quality can be made to identify changes occurring immediately after the eruption.

Complementing current research efforts in Campania by Italian geologists and archaeologists, this program aims to demonstrate and document any significant demographic, environmental and cultural impacts that would result from the presence of the postulated Early Bronze Age refugee population in South Lazio. Three post-doctoral researchers, experienced in interdisciplinary geoarchaeological studies, will investigate these interrelated impacts and assess the multiple lines of evidence needed to substantiate or disprove our central hypothesis.

Structure of the Research

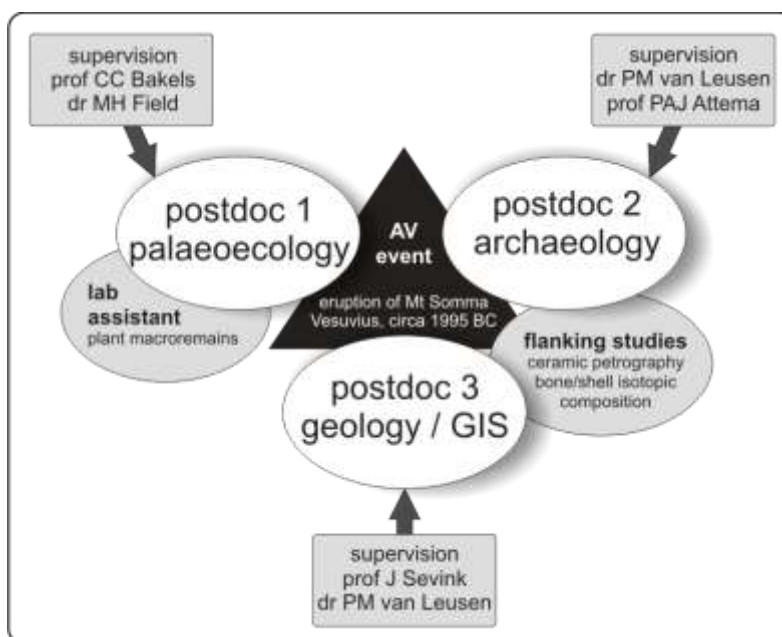
The program consists of three interrelated post-doc projects (see figure below), in the fields of palaeo-ecology, archaeology, and geology/geography:

1. *Distal Palaeoecological Impacts of the Avellino Event*. A 3 year fte post-doc project (Leiden University, Faculty of Archaeology; supervision by prof. Bakels): dr Marieke Doorenbosch.
2. *Distal Archaeological Impacts of the Avellino Event*. A 3 year fte post-doc project (Groningen University, Faculty of Arts; supervision by prof. Attema): dr Luca Alessandri.
3. *Reconstructing the Buried Early Bronze Age Landscape of South Lazio*. A 2 year fte post-doc project (Groningen University, Faculty of Arts; supervision by prof. Sevink): candidate to be sought in an open call.

For much of the time, these three post-docs will be working closely together to develop the research program, conduct joint fieldwork in Italy, and publish jointly.

Post-doc 2 will have the additional task to liaise for the team with heritage managers, local authorities and researchers in Italy, as well as further publications in Italian journals. Post-doc 3 will be responsible for the development and maintenance of the team's digital geodata (GIS) infrastructure. This core research team will be assisted throughout by a part-time student assistant (0.05 fte) who will be responsible for the team's archiving and publicity.

For specialist analyses, the team will be able to call on both in-house and external expertise. A lab technician, based at Leiden University and supervised by dr Field, will be contracted at certain stages of the research for the analysis of plant macrofossils (4 months at 0.5 fte), and Italian university laboratories will be contracted to conduct 'flanking' archaeometric studies for the petrographic analysis of pottery and the isotope analysis of shells and bones.



Description of the Research

About four thousand years ago, a major eruption of the Monte Somma Vesuvius devastated the landscape and the flourishing Early Bronze Age society then occupying the southern part of the region of Campania (Italy). Following an initial small eruption, which is thought to have allowed the population to flee the area, heading inland rather than towards the sea, the so-called Avellino (AV) pumice eruption phase deeply buried the Early Bronze Age landscape to the north and east of the volcano (Sulpizio et al. 2010). It was only during construction work in 1972, near the town of Palma Campania, that the first settlement buried by the Avellino eruption was discovered (Albore Livadie 1980). Since then, Italian archaeologists have uncovered and described many more Early Bronze Age settlements of this so-called 'Palma Campania *facies*', all with clear stratigraphic connections to the eruption (Albore Livadie 1999; Di Vito et al. 2009; Saccoccio et al. 2013; Talamo 1998). Some of the remains, perfectly preserved by the eruption products, have been deservedly publicised as 'the Bronze Age Pompeii'.

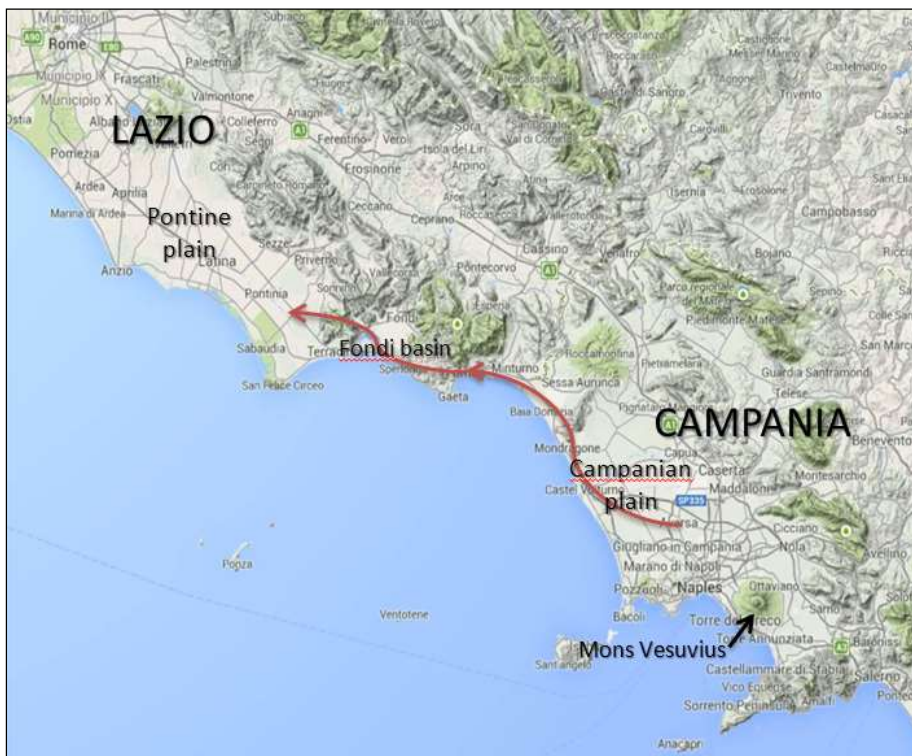


Top - People fleeing with their cattle from a recent eruption of Mt. Sinabong (Indonesia).

Bottom – Household items left behind in the Bronze Age village of Nola after the inhabitants fled the Avellino eruption. Hut walls, molded in hardened volcanic ash, have been preserved to a height of about 1m.

Further away from Mount Vesuvius the impact of this eruption would obviously have been less devastating, but in these distal areas the Avellino ash can still be found in sediment cores from lake beds and from the Adriatic seabed, where they form an excellent tephrochronological marker bed (e.g. Sulpizio et al. 2008; Zanchetta et al. 2011). The precise date of the Avellino eruption, which has long been the subject of debate among archaeologists and geologists, was recently fixed by robust radiocarbon dating to 1995±10 BC (Sevink et al. 2011 and 2013; see also Passariello et al. 2009). The Avellino eruption must have wrought both immediate and long-lasting havoc in much of the Campanian coastal plain. Dramatic evidence is available to show that people were forced to flee taking only their most valuable possessions, and were unable to save all of their livestock (Passariello et al. 2009). At a somewhat longer time-scale, major historic ash falls of only a few cm thickness are known to have caused mass starvation by destroying crops (Self 2006), and thicker ash falls may severely affect topography, hydrology, and soil properties. A recent review of archaeological research in Campania (Di Lorenzo et al. 2013) concludes that, whilst a few areas seem to have recovered within decades after the Avellino eruption, it took up to several centuries before the Bronze Age population had fully recovered to pre-eruption levels.

Whilst the impact of the eruption within Campania itself continues to be studied intensively, little thought and no research effort has so far been spent to establish the subsequent whereabouts of the refugee Early Bronze Age people population. The **central hypothesis** of this research program is that a significant percentage of the refugees must have decided to resettle in the nearest coastal plains to the north - the Pontine Plain and Fondi Basin of South Lazio, and that we should therefore be able to prove this by tracing the **ecological, demographic and cultural impacts** that this immigrant population must have had. That no such impacts have yet been found despite the long Dutch tradition of landscape research in Southern Lazio is, as we shall argue below, due to the particular geological history of this area.



Central Italy, with hypothetical route taken by the Early Bronze Age refugee population. Nola, a.k.a. the 'Bronze Age Pompeii', lies just northeast of Vesuvius.

Starting in the 1970s, the soils and geology of the south Latial coastal plains (the Pontine plain, Fondi basin and Garigliano delta) were studied and mapped in detail by physical geographers from the University of Amsterdam (Sevink et al. 1984). Later on, the archaeology of the Pontine plain was studied by teams from the Universities of Amsterdam, Leiden and Groningen (Voorrips et al. 1991; Attema 1993; Van Leusen 2002; Van Joolen 2003). In particular, the recent investigations by the Groningen Institute of Archaeology in the Pontine plain have conclusively demonstrated that Bronze Age sediments and, indeed, settlements have been preserved deep beneath more recent geological strata (Feiken et al. 2012; Feiken 2014). Being part of a geologically sinking zone (a *graben*), nearly all of the archaeological evidence for the Early and Middle Bronze Ages has now been shown to lie buried some 1.5m below the present land surface – a depth reached only rarely by modern agricultural and construction work. This explains why the Italian State’s archaeological records for the coastal plains of south Lazio contain only three finds locations of Early Bronze Age sherds (the details of a fourth location have been lost; Alessandri 2007). Interestingly, those same records show that in the *next* phase (Middle Bronze Age 1/2) the Pontine Plain becomes much more densely populated, just when the population of Campania reaches its lowest ebb following the Avellino eruption (Alessandri 2013) ...

Crucially for the research program, the distal ash from the Avellino eruption has now been found in the Pontine Plain in the sediments of a large late Holocene inland lake and river plain. Corings and test trenches (extensively described in Bakels et al. in prep, Feiken et al. 2012 and Feiken 2014) demonstrate that these sediments hold rich paleo-ecological and archaeological records. These discoveries now for the first time open up the exciting possibility of a detailed study of the Early Bronze Age in the coastal plains of southern Lazio – in particular with regard to the environmental and cultural impacts of a refugee population fleeing both from the eruption itself and from its adverse long-term effects back home in Campania.

Scientific quality

This research program is designed to test a clear hypothesis – that a refugee population from Campania settled in the south Lazio coastal plains immediately after the Avellino eruption – by tracing the environmental and cultural effects that such a population influx would have caused. For the most part it is based on the application of tried-and-tested methods and approaches in archaeological and environmental research, in which the applicants have long and demonstrated experience, but a small program of more innovative (and risky) ‘flanking’ archaeometric studies of human skeletal material and of selected pottery is foreseen in the hope that we will be able to provide *direct proof* for the presence of Campanian immigrants and their household wares in South Lazio immediately after the Avellino Event.

The desktop and field studies build on a body of existing knowledge and data derived from three decades of Dutch archaeological and environmental research in south Lazio, and on a similar body of research built up by Italian researchers since the 1980s for the Campanian plain. Following an initial phase in which the team will conduct a desktop reassessment of the available evidence for optimal targeting of field studies, an extensive manual and mechanical coring program, using prospection approaches developed in the Netherlands (Tol et al. 2004), will be conducted to obtain detailed records of geostratigraphy and subsurface archaeological indicators. The evidence for demographic and economic/ecological impacts produced by this coring program cannot prove directly that the

hypothetical migration took place. Hence, following analysis of the data thus obtained, a selection will be made of sites and zones that have a proven stratigraphy dating to just after the Avellino Event. These will be targeted for more intensive study and sampling in cores and test pits, to obtain cultural and environmental proof for the local presence of immigrants from Campania.

Should the research lead to a rejection of our main hypothesis, then the program will still result in major advances to our understanding of the archaeology of the protohistoric period in south Lazio. We will then have produced detailed reconstructions of its geostratigraphy (including the occurrence of the AV-ash), its vegetation history, and its Early to Middle Bronze Age settlement history. The feasibility of the flanking archaeometric studies will depend on the availability of suitable bone and pottery samples for study from already excavated sites or from the test pits proposed here. If these studies fail to provide direct proof they will still result in the publication of valuable 'background' isotopic and petrographic data as a foundation for future research into migration and exchange in Central Italy.

Crucially, the research requires the multi- and interdisciplinary use of geological, geographical, palaeoecological and archaeological approaches. The main applicant's research group has two decades of experience with this type of research in Italy and is cognizant of the effort that is needed for such programs to run effectively.

Structure of the program

The core of the research program consists of three closely linked research projects, each requiring an experienced researcher. A detailed understanding of the soils, lithology and geochronology in their spatial context (postdoc 3) must underlie the sampling, analysis and interpretation of the archaeobotanical record (postdoc 1) and of the archaeological record of the Early to Middle Bronze Age (postdoc 2). The interdisciplinary character of the program requires that the postdocs develop a joint detailed research plan, in which time is allowed to overcome terminological and methodological differences. They will also need to conduct at least two large joint fieldwork campaigns, since corings and test pits must produce the data required by all three subprojects. The data collected from the initial desktop studies and later on in the field will be managed in a project GIS environment hosted at the University of Groningen, and project publicity (a website, blog and academia page) will be jointly maintained with the help of a student assistant. With regard to the postdoc archaeologist (postdoc 2) it should further be noted that the research program is crucially dependent on the establishment and maintenance of good collaborations with relevant Italian research groups, regional heritage management organizations, and local authorities. This postdoc will therefore spend a substantial part (up to 20%) of his time locally on the logistic facilitation of the program.

After the startup phase the applicants' role will be to supervise, at roughly monthly intervals, the running of the research program and to ensure that the timetable does not lapse. By the end of the second year the research team will have produced its primary technical reports detailing the pale-environmental, geological and archaeological data produced from fieldwork and in the laboratory; in the third year it will produce analytical papers based on these. During the final year of the program, the applicants will use these to synthesize the results of the research in the form of two large articles

in high-impact journals (this will ensure speedy publication). This synthesis will for the first time provide a comprehensive view of the distal archaeological effects of such a large eruption.

Organization and embedding

The department of Classical and Mediterranean Archaeology at the University of Groningen (RUG-KMA) has extensive experience with multidisciplinary research projects in Italy going back 15 years, and will host the geological and archaeological parts of the program, embedding them in the long-term Pontine Region umbrella project directed by the main applicant. The pollen and plant macroremains studies will be hosted at the new purpose-built paleoecology laboratory at the Faculty of Archaeology of Leiden University, under the supervision of prof Bakels and dr Field. This provides access to extensive reference collections for pollen, spores, seeds and fruits, and to experienced staff with an international reputation (Bakels 2000a; Bakels et al. in prep; Sevink et al. 2013). Further specialist assistance, if needed, will be available from the applicants' laboratories for ceramic and environmental studies at Leiden and Groningen Universities, and (for dating assistance) the Center for Isotope Studies at Groningen University.

For the flanking archeometric studies, contacts have already been made with laboratories in Modena, Rome and Naples. The preparation of petrographic thin sections will be conducted commercially and the analysis will take place at the Department for Chemistry and Geological Sciences of the University of Modena and the Institute for Volcanology and Geophysics at Naples for the tephrochronological aspects (supervisors: dr. Sara Levi and dr. Mauro di Vito). The bone/shell isotopic analyses and interpretations will be conducted at the laboratory of the Department of Biology at the University of Rome 'Tor Vergata' and will be supervised by dr. Flavio de Angelis.

Knowledge utilization

The knowledge generated by the program will be utilized within the discipline (extending and fuelling the debate on the Early Bronze Age in central Italy, and furthering the uptake of isotopic studies), in neighbouring disciplines (Paleoecology, Geology and Heritage Management) and for the general public in Italy and the Netherlands.

We foresee several potential scientific impacts of the research program outside of the applicants' immediate circle:

- the program will deliver a detailed palaeogeographical reconstruction of the south Latial plains that can be used by other archaeologists and environmental scientists working in the region;
- the flanking studies on Strontium isotope ratios and pottery petrography will, even if they fail to prove immigration directly, produce baseline data which can be used by other archaeologists working in the region;
- wider diffusion of the use of the Avellino ash as a new and robust chronological marker will be of great significance for the pottery-based typochronology of the EBA and early phases of the MBA in central and southern Italy;
- the institution responsible for the protection of archaeological remains in the study area - the *Soprintendenza per i Beni Archeologici del Lazio* – will profit by obtaining high-resolution

information about the depth and quality of the archaeological record (a 'risk map'). This is the kind of data on which to base a revised heritage management regime.

In view of the fact that we are dealing here with an exceptional archaeological case in which a dramatic past *event* can be studied, the potential interest from the population, media, museums and local authorities in the study area will probably be very large. The valorisation budget of the project will allow the preparation of leaflets for use in Italy. With regard to the general public we intend to have a TV documentary made to inform about the reality of modern landscape archaeological approaches - a thoroughly interdisciplinary field that deserves better than the 'mystery' touted in the typical National Geographic documentaries. Since this is not an area in which the applicants have any expertise, contacts have already been established with documentary film producers to ensure realistic planning and to formulate scenarios and scripts. The aim is to produce a high impact popular scientific TV production for Dutch and international audiences.

In conjunction with work for the documentary, students and teachers of archaeology worldwide will be served by a series of internet video shorts, shot in part on location in the field and laboratories and distributed as Open Courseware teaching materials. Each 10 minute video short will show and explain one particular type of research: mapping, coring, bone isotope analysis, pollen and macrofossil analysis, excavation procedures, et cetera. A University of Groningen didactic specialist will work with the applicants and the external video company to formulate scenarios and scripts for these.

SUBPROJECT DESCRIPTIONS

Please note that the phrasing of the following three subprojects is nearly identical because they will be collaborating closely; details of this are provided under the heading 'work program'.

Postdoc project 1: Distal Palaeoecological Impacts of the Avellino Event.

The main task of this postdoc, for which a suitable candidate has already been identified at Leiden University, will be to use pollen and macrofossil data to reconstruct the vegetation in the coastal wetlands of south Lazio before and after the Avellino eruption. The aim of this work is to detect the environmental impacts brought about by the influx of the postulated substantial body of immigrants from Campania. Generally an increase in population density leads to increased deforestation and anthropogenic land use, both of which can be detected through the analysis of pollen and botanical macroremains.

The macrofossils research (site level) is intended to act as an independent check on the pollen data (regional level). In contrast to the pollen signal, seeds and fruits are identifiable to species level. Moreover they can provide taphonomic information suitable for building up a picture of the local food economy. The postdoc (supervised by prof Bakels) will conduct and publish the pollen analysis, and the plant macrofossil work will be done by Dr M.H. Field with the help of a lab assistant.

New pollen corings are needed because past cores do not cover enough parts of the ancient lakes and their surroundings to provide the high resolution data needed. From every core only those parts will be analyzed which help to solve our questions concerning the possible impact of the Avellino eruption on the population of the Fondi Basin and the Agro Pontino. Sampling locations for both palynological and plant macrofossil investigations will be carefully chosen from the margins of

the former lakes within the Pontino and Fondi sedimentary basins to provide suitable archaeobotanical data, taking into account the requirements of all three researchers. These requirements include obtaining data from those landscape zones that are most likely to reflect changes in habitation and land use. The interpretation of the pollen diagrams also relies on collaboration between the researchers. For example, the effects of lake level changes on the vegetation and land use will have to be modeled, and certain potential anthropogenic indicators must be interpreted in the light of available archaeological knowledge.

Sediment samples will be taken from cleaned sections or by taking cores. It is envisaged that four cores/sections will be sampled and analyzed from the larger Agro Pontino sedimentary basin, and three cores/sections from the Fondi basin. High resolution sub-sampling of the cores and monoliths from the sections around the Avellino tephra layer will provide a detailed record of how the environment changed immediately after that event. Preliminary investigations on two sections from the Agro Pontino plain have already shown that relevant archaeobotanical data can be generated (Bakels et al., in prep). A fine chronology will be produced using the characteristic Avellino tephra layer and the results from eight AMS dates obtained from terrestrial plant macrofossils.

As specified in the section on 'planned deliverables' below, postdoc 1 will publish technical reports describing the research and its primary results, and (jointly with the other postdocs) analytical papers detailing the scientific significance of the work. The paleo-ecological reconstruction produced by this postdoc will be one of the main inputs for the synthetic work of the applicants.

Postdoc project 2: Distal Archaeological Impacts of the Avellino Event.

This postdoc will commence by conducting a desktop study of the available archaeological evidence for EBA and MBA settlement in south Lazio, extending the work of Alessandri (2009, 2013). He/she will also critically review the existing pottery typologies for Campania and south Lazio in order to identify and describe a) the cultural and chronological traits pertinent to the period either side of the Avellino Event, and b) the type and amount of uncertainty remaining in currently accepted pottery typochronologies for the period under study. An experienced researcher is needed for this project, and a suitable candidate is already available in the person of dr Alessandri.

During the fieldwork phase of this project the postdoc will revisit, together with postdocs 1 and 3, as many of the known but poorly documented sites and scatters of the EBA and MBA period in the study area as possible. The goal here is to extract the missing stratigraphic and paleogeographic information by coring, as well as look for additional diagnostic pottery to firm up the cultural and chronological identification. The postdocs will collaborate to design a coring program that will systematically identify archaeological 'indicators' (fragments of bone, charcoal, and pottery) associated with the AV Event in the landscape zones deemed the most attractive to our postulated Early Bronze Age immigrants.

On the basis of the analysis of the coring data and desktop study, the postdoc will select a small number of archaeological sites that have the potential to demonstrate the appearance of post-AV 'Campanian' cultural affinities at pre-existing 'Latial' sites. During a second fieldwork period these will be investigated with test pits to obtain (additional) diagnostic pottery and samples for macroremains.

A crucial task of this postdoc will also be to maintain and, where necessary, develop good relations with local heritage management officers and government bodies to ensure effective planning and execution of field work. As part of this task, the postdoc will be responsible for maintaining the program's publicity in the Italian language and ensuring that its main results will also be published in Italian. All of this is estimated to take up 25% of the postdoc contract.

Whilst it is possible that high-value (and therefore easily recognizable) objects were taken along by the fleeing population, a safer way to directly identify pottery transported from Campania after the AV Event would be to use petrography to identify inclusions that only occur in the Campanian geological province. For this specialist work the postdoc will work with experienced petrographers using lab facilities in Italy. A second potentially fruitful approach to proving the presence of post-AV Event Campanian immigrants in south Lazio would be to detect a 'Campanian' geological signature in their skeletal remains by means of Strontium (Sr) isotope analysis. This will require, firstly, the establishment of the appropriate local 'background' Sr signatures and, secondly, the comparison against these of the Sr signatures from carefully selected samples of human bone and teeth. Ideally, Sr signatures in teeth would then demonstrate the deceased spent his youth in Campania whereas that of the bones will attest to his adulthood in Lazio. Together with postdoc 3, the postdoc will be responsible for selecting shells and bones suitable for isotopic studies, to be conducted by a specialized laboratory in Italy (see section on 'flanking studies').

As specified in the section on 'planned deliverables', postdoc 2 will publish technical reports describing the research and its primary results, and analytical papers detailing the scientific significance of the work. The archaeological interpretations produced by this postdoc will be one of the crucial inputs for the synthetic work by the applicants.

Post-doc project 3: Reconstructing the Buried Early Bronze Age Landscape of South Lazio.

This postdoctoral researcher will have two tasks: firstly, to refine Feiken's (2014) geological and palaeogeographical reconstruction of the central Pontine graben, expand it to the southeastern coastal area and the adjacent Fondi basin, and assist postdocs 1 and 2 in selecting the most suitable new locations for coring; and secondly to provide the geodata framework and GIS support for the research team as a whole. An experienced researcher is needed for this subproject both to conduct a substantial coring program covering the southeastern part of the Pontine plain and the Fondi basin in a relatively short time, and to be able to provide GIS services from an early stage in the project. It is anticipated that this work can nonetheless be done in part-time (0.6 fte).

Before and during the first fieldwork period this postdoc will work closely with postdoc 1 to identify locations suitable for the collection of pollen cores, and with postdoc 2 to identify the most promising potential new archaeological site locations dating to the EBA-MBA in these areas. He will help both postdocs conduct these necessary corings and ensure that they are described according to current geological standards. Besides setting up and maintaining a joint GIS geodatabase for the research team, the postdoc will supervise the submission of samples for radiocarbon dating, petrographic and isotope analysis.

The main scientific work of this postdoc will be to design and conduct (with the help of students) a systematic manual coring program to map the AV-ash and any archaeological indicators of EBA-MBA

habitation or land use in the Pontine plain and Fondi basin, and thereby extend the geological and palaeogeographical reconstructions by Feiken (2014) in these areas. As specified in the section on 'planned deliverables', postdoc 3 will publish technical reports describing the geological research and its primary results, and (jointly with postdoc 1) analytical papers detailing the scientific significance of the work. The geological interpretations produced by this postdoc will be one of the main inputs for the synthetic work by the applicants.

Flanking archaeometric studies

In support of the work of postdoc 2 in particular, two sets of archaeometric studies will be conducted by external laboratories with the aim of providing direct proof of the presence in south Lazio of refugees from Campania and/or their household items. The work will be supervised by members of the team's advisory committee and the results will be delivered to the team in the form of technical reports (data plus interpretation):

- The possibility that pottery imported into South Lazio from Campania has a distinct composition (containing volcanic products not present in the former region) will be investigated using petrographic analysis of EBA-MBA pottery samples from both regions. An initial bibliographic study suggests that little or no relevant data are yet available (Albore Livadie et al. 2001; Passariello et al. 2009). We will engage an Italian laboratory at the University of Modena and Reggio Emilia to conduct the work, which is to be supervised by postdoc 2.
- Immigrants (whether people or animals) from Campania should be directly traceable through Strontium isotope (Sr) analysis on skeletal remains, if the two provinces are found to be sufficiently distinct in their geology. Sr is naturally present in rocks and minerals and its isotopes ratio varies with respect to age and geological environment. As rocks weather into soils, the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio enters the food chain and ends up in animal and human tissues. Since tooth enamel in particular does not change after mineralization, its Sr reflects the local ratio of the area in which a person grew up whereas his bone Sr signature reflects the area in which he died. Sr analysis is an effective and widely used technique to assess ancient mobility (Ericson 1985; Price et al. 1994 and 2002; Giblin et al. 2013), and good local Sr ratio signatures may be obtained from skeletons from excavated burials at Grotta Vittorio Vecchi (Rosini 2007) and Valvisciolo/Caracupa (Angle & Gianni 1985) as well as from small animal bones from the Tratturio Caniò excavation (Feiken et al. 2012). Sr analysis of tooth enamel from the earliest post-AV sites (e.g., Grotta Vittorio Vecchi) could then provide direct proof of a non-local origin. This specialist pilot study will be conducted at the Laboratory of Anthropology, University of Rome 'Tor Vergata', under the supervision of postdoc 2 and of Dr Flavio de Angelis, in consultation with the archaeologists responsible for the excavated sites.

If these studies are successful, they will be published jointly with the participating laboratories and the results will be used to enhance the synthesis (below); if they are not, the results will be evaluated by the applicant and published as a methodological exercise.

Synthesis

Pulling all the evidence together during the final year of the research program, the applicants will use the postdoc's analyses of the paleo-ecology, paleogeography and archaeology of the study area

to prepare two large international interdisciplinary research articles synthesising the results and implications of the work. The first will be descriptive, focusing on the reconstruction of the Early to Middle Bronze Age landscape of the Pontine plain and the Fondi basin, and will be offered to *Quaternary Science Reviews*; the second will be interpretative, focusing on the archeological, paleo-ecological and geological effects of the Avellino Event, and will be offered to *Journal of Field Archaeology*.

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Work Program

The work program, summarized in the diagram below, consists of seven phases indicated by Roman numerals. The startup **phase I** (months 1-6) is used for job advertising & interviews, obtaining permissions and arranging logistics for the first joint field campaign, building the team's GIS environment and website, and desktop studies. That fieldwork, encompassing the geoarchaeological coring campaign, archaeological revisits, and pollen cores & macroremains sampling, is conducted in **phase II** (months 7 – 9). About half of the analysis **phase III** (months 10 – 15) is used to complete preliminary internal reporting on the fieldwork, the other half in preparations for the second joint field campaign. At the start of this phase, the petrography and Strontium isotopic work should be tendered. Invasive fieldwork at selected sites takes place in **phase IV** (months 16 – 18), and this is again followed by a lengthy analysis and publication phase in which preliminary internal reports are prepared on the primary field and lab results (**phase V**, months 19 – 27); optionally, a brief third field campaign may be necessary during this phase for 'mopping up' remaining uncertainties in the field data. Technical publications based on these internal reports are prepared by the postdocs in **phase VI** (months 28 – 36), and synthetic publications by the postdocs and the applicants in **phase VII** (months 37 – 48). In the final three months of the program, postdoc 3 will focus on archiving and the submission of specific datasets to digital repositories.

year	1				2				3				4			
month	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34-36	37-39	40-42	43-45	46-48
Project phase	I		II	III		IV	V			VI			VII			
Postdoc 1	0.8	a1		n1			o1					e1				i1
Postdoc 2	0.8	a2		n2			o2					q, r, e2				i2
Postdoc 3	0.6			n3			o3					e3				i3
Research assistant	0.5						p									
Student assistant	0.05	m														
Applicants		b										f				j
milestones				c	d				l			h	g			

Note: this program takes into account vacations (not shown). For details on deliverables, see item 13 of this application form.

Postdocs 1 and 2 are working at 0.8 fte; postdoc 3, working at 0.6 fte, will start and end three months later to ensure the continuation and archiving of the team's geodata infrastructure during the final synthetic work. Postdocs 1 and 2 begin Phase I with a desktop study describing the status quo of paleoecological and archaeological research in South Lazio (internal deliverables a1-2); meanwhile postdoc 3 focuses on the building of the team's GIS environment. All three then conduct two joint field campaigns each followed by an analysis phase (phases II – V), producing preliminary reports on the work within 3 months of the end of the fieldwork (internal deliverables n1-3, o1-3). The research assistant for microfossils analysis produces a technical report after the second fieldwork period (internal deliverable p).

In the first fieldwork period (phase II) postdoc 1 will focus on the collection of the requisite pollen cores from the Pontino and Fondi basins, whilst postdocs 2 en 3 will conduct an extensive systematic geoarchaeological coring campaign to map the distribution of geological and archaeological strata. Phase III is used for the analysis of the coring and survey results and the selection of targets for the phase IV fieldwork (test pits and paleoecological, geological and

archaeological sampling); the final decision on this selection is made by the team together with the advisory committee, and constitutes **milestone d**.

In phase V the data and samples collected in the phase IV fieldwork are analyzed. For the most part this is done by the postdocs but samples for petrographic and Strontium isotopic analysis will be analyzed by external laboratories under the supervision of postdoc 2 (deliverables q, r). In phase VI and VII the postdocs prepare the publication of technical reports and synthetic articles (deliverables e1-3 and l1-3)

The applicants supervise the development, by an external company, of the teaching videos and TV documentary (deliverables b, f, and g) as well as the work of the student assistant responsible for publicity (deliverable m); this work is completed with the publication of the open courseware video shorts on the RUG servers (**milestone h**). They will organize an international expert meeting on the impacts of volcanic eruptions marking the end of year 1 (**milestone c**) and arrange the publication of edited proceedings to mark the end of phase V (**milestone l**). In the final phase they produce the synthetic publications (deliverable j) and supervise the preparation, by postdoc 3, of the digital archives for submission to international repositories (**milestone k**).

Planned Deliverables

Project month	Deliverable	Details
3	a: internal reports on status quo	a1: report on the paleo-ecological status quo a2: report on the archaeological status quo
3	b: full TV documentary scenario	To be developed by applicants together with external partner
6	m: project web presence going live	GIA research projects website, maintained by student assistant
19-21	p: macrofossils report	by research assistant under supervision of Dr. Field
27	l: publication of edited proceedings from the expert meeting on volcanism	BAR international series volume
34-36	e: descriptive publications (postdocs)	e1-3: full technical reports on pollen diagrams, survey and excavation results, and geological/paleogeographical reconstructions as arising from field and lab work, to be published in the Leiden ASLU and Groningen Palaeohistoria series
34-36	f: TV documentary	
34-36	q, r: archaeometric reports	q: technical report on petrographic analysis by external lab r: technical report on Strontium isotopic work by external lab
34-36	g: Open courseware – videos	Publication of 5 to 20 video shorts via RUG open courseware server.
43-45	i (postdocs): synthetic publications in specialized journals	Postdocs 1 + 3 article 1: paleogeography and paleoecology of the study area before, during and after the AV-event (in <i>Quaternary Science Reviews</i> or <i>Quaternary International</i>) Postdocs 1 + 3 article 2: paleogeographical and palaeoecological evolution of the South Lazio coastal plains after the Bronze Age (in <i>Quaternary International</i>) Postdoc 2 article 3: archaeological indicators from the coring survey and revisits (methodological article for <i>Scienze dell'Antichità</i> or <i>Journal of Field Archaeology</i>) Postdocs 2 + 3 article 4: identifying archaeological remains in coastal basins (methodological article for <i>Geoarchaeology</i>) Postdoc 2 article 5: archaeological results from the test pits (in <i>Palaeohistoria</i>) Postdoc 2 article 6: Early-Middle Bronze Age pottery – chronotypological development, archaeometric results and contacts between Lazio and Campania (in <i>Scienze dell'Antichità</i> or <i>Origini</i>)
46-48	j (applicants): synthetic publications in A-journals	S1 article on EBA-MBA landscape reconstruction, for publication in <i>Quaternary Science Reviews</i> ; S2 article connecting the archeological, paleoecological and geological results, for publication in <i>Journal of Field Archaeology</i> .
46-48	k: submission of digital research archive to repository	Coring database Pollen database DANS repository

Short CV of the main applicant

Peter Attema has been professor of Classical and Mediterranean Archaeology in the Department of Archaeology of the University of Groningen since December 1999. He is currently director of the research institute Groningen Institute of Archaeology, and is a member of the National Research School Archon. His main research interests are the processes of centralization and early urbanization in Central and south Italy and the interaction of Greek and Roman colonization with indigenous societies in the Mediterranean and Black Sea regions. He directs several landscape-archaeological and excavation projects and is (co-)author and editor of monographs, journals, reports and peer-reviewed papers (see for a full list: rug.academia.edu/PeterAttema; selected books and papers are listed below). Since 2002, he has been promoter of twelve successful PhD's in archaeology and second promoter of two successful PhD's in Ancient History. He has served on dissertation committees in the Netherlands, Belgium, and Italy.

Selected recent books and peer reviewed papers

- Attema, P.A.J. (2013), *Crustumium, Ricerche internazionali in un centro Latino / Archaeology and Identity of a Latin Settlement near Rome* (edited with F. di Gennaro and E. Jarva), *Corollaria Crustumina* **1**, Barkhuis & Groningen Institute of Archaeology (edited volume on international excavation project near Rome).
- Attema, P.A.J. (2012), *The Dzarylgach Survey Project* (edited with P. Guldager Bilde and K. Winter-Jacobsen), Aarhus University Press (project monograph in 2 volumes).
- Attema, P.A.J. (2012), Comparative issues in the archaeology of the Roman rural landscape, site classification between survey, excavation and historical categories (edited with Günther Schoerner), *Journal of Roman Archaeology, Supplementary Series* **88**, Portsmouth, Rhode Island (edited methodological volume with position paper and contribution).
- Attema, P. and T. de Haas (2011), Rural settlement and population extrapolation, a case study from the ager of Antium, central Italy (350 BC – AD 400), in Bowman, A. & A. Wilson (eds), *Settlement, Urbanisation and Population. Oxford Studies on the Roman Economy* **2**, Oxford, pp. 97-140. (Paper on the methodology of population extrapolation from survey data).
- Attema, P.A.J., de Haas T.C.A., Tol, G.W. (2011). *Between Satricum and Antium, Settlement Dynamics in a Coastal Landscape in Latium Vetus, Babesch Supplement* **18**, Peeters, Leuven – Paris – Walpole, MA. (project monograph).
- Attema, P.A.J., Burgers G.-J., van Leusen P.M. (2010). *Regional Pathways to Complexity, Landuse Dynamics in early Italy from the Bronze Age to the Republican period, Amsterdam Archaeological Studies* **15**, Amsterdam University Press, Amsterdam (project monograph of major NWO project).

Dutch Summary for Non-specialists

Rond 2000 voor Christus, in de Vroege Bronstijd, vond een grote uitbarsting van de Vesuvius plaats die tot in de verre omtrek het land ongeschikt maakte voor bewoning of landbouw. Velden en nederzettingen werden tot meters diep onder de vulkanische as begraven, en het heeft waarschijnlijk honderden jaren geduurd voor de bevolking zich weer van deze ramp hersteld had. Onder de as zijn op vele plaatsen in de huidige regio Campanië vanaf de jaren '70 van de vorige eeuw bijzonder goed bewaarde archeologische vindplaatsen ontdekt die getuigen van de dramatische gebeurtenissen: voetsporen van bewoners en vee die op de vlucht zijn geslagen, skeletten van vee dat het niet gered heeft, en huizen waarvan vrijwel de volledige huisraad achtergelaten moet worden om het vege lijf nog te kunnen redden. De bekendste van deze vindplaatsen, Nola dat vlak ten noordoosten van de Vesuvius is gelegen, wordt dan ook wel 'het Pompeii van de Bronstijd' genoemd. Naar de plaats waar de as van deze uitbarsting voor het eerst geologisch beschreven is, wordt dit de 'Avellino-eruptie' genoemd.

Het doel van deze onderzoeksaanvraag is om, complementair aan het bestaande Italiaanse archeologische onderzoeksprogramma naar de effecten van deze Avellino-eruptie, te bewijzen dat er als gevolg van de eruptie een gedwongen migratie van de Vroege-Bronstijdinwoners van Campanië naar de direct ten noorden ervan gelegen kustvlakten van zuid-Lazio heeft plaatsgevonden. Hiervoor gaan we een combinatie van paleoecologisch, paleogeografisch en archeologisch onderzoek inzetten, uit te voeren in de 'wetlands' van het Fondi-bekken en de Pontijnse vlakte ten zuiden van Rome. We maken daarbij gebruik van technieken en benaderingen die in de veen-en-kleibodems van west-Nederland zijn ontwikkeld: een programma van handmatige grondboringen levert zowel de botanische gegevens (vooral pollen) waarmee de impact van een plotselinge bevolkingsaanwas in zuid-Lazio kan worden aangetoond, als de benodigde aanwijzingen (houtschool, bot, aardewerk en vuursteenfragmenten) voor het karteren en dateren van archeologische resten uit de Vroege Bronstijd. In principe kunnen we op deze manier zowel de aangroei van de bevolking (door immigratie van vluchtelingen uit Campanië) als hun invloed op de lokale vegetatie (bijvoorbeeld door het ontginnen van bos of het platbranden van veengebieden) aantonen. Het is daarbij natuurlijk van groot belang dat de archeologen kunnen onderscheiden wat er vlak vóór en vlak na de Avellino-uitbarsting gebeurde, en gelukkig kunnen we daarvoor gebruik maken van een in 2009 voor het eerst aangetroffen (en met zekerheid afkomstig van de Avellino-eruptie) aslaag, gedateerd op 1995 voor Christus. Deze slechts 1 cm dikke aslaag is op veel plekken bewaard gebleven en fungeert voor de onderzoekers als 'gidslaag' waarmee relatief eenvoudig paleogeografische kaarten van het te onderzoeken gebied gemaakt kunnen worden.

Naast de door middel van grondboringen *indirect* af te leiden bevolkingsaanwas die chronologisch direct op het 'Avellino-Event' zou moeten volgen, willen we ook de culturele impact van die migratie aantonen door hernieuwd onderzoek te doen aan al bekende maar vaak slecht gedocumenteerde Bronstijd-vindplaatsen - deze zijn in 2009 geïnventariseerd door RUG-promovendus dr. Alessandri – en door het opsporen en aardewerktypologisch analyseren van vindplaatsen die in stratigrafisch contact met de AV-aslaag staan. In principe is het namelijk mogelijk om in Campanië gemaakte, en vervolgens naar zuid-Lazio gebrachte potten te herkennen aan hun specifieke vorm en versiering.

De drie hoofdonderdelen van het programma zullen elk door een ervaren onderzoeker uitgevoerd worden, die op basis van de al beschikbare data het onderzoek, inclusief geplande publicaties, gericht en efficiënt kan uitvoeren. Voor het voorbereiden, uitvoeren en publiceren van een boorprogramma resulterend in een gedetailleerde vegetatiereconstructie van het onderzoeksgebied, onder begeleiding van prof. Bakels en Dr. Field (beide Universiteit Leiden) is een paleo-ecoloog nodig. Voor het voorbereiden, uitvoeren en publiceren van het aanvullend

archeologisch veldonderzoek aan Bronstijdvindplaatsen en het aardewerktopologisch onderzoek, onder begeleiding van prof. Attema en Italiaanse experts, is een archeoloog nodig. Voor het voorbereiden, uitvoeren en publiceren van een voornamelijk op boringen gebaseerd paleogeografisch onderzoek dat zich zal focussen op de Bronstijdfasen in de geologische en archeologische stratigrafie van het onderzoeksgebied, onder begeleiding van prof. Sevink (UvA/RUG), is een ervaren kartograaf/geoarcheoloog nodig. Deze drie onderzoekers zullen met betrekking tot de specialistische analyse van macro-plantenresten, aardewerksamenstelling (petrografie) en samenstelling van skeletresten (Strontium isotopenanalyse) worden ondersteund door externe specialisten en laboratoria.

Dit onderzoeksprogramma, uitgevoerd door een interdisciplinair en ervaren team, zal niet alleen bijdragen aan het beantwoorden van één van de grote vragen uit de Italiaanse protohistorie – hoe groot was de impact van de Avellino-eruptie op de economie en maatschappij van de Vroege Bronstijd? – maar zal bovendien het eerste systematisch opgezette en uitgevoerde onderzoek naar de ‘distale’ (ver van de bron van de ramp gelegen) effecten van grote rampen in het verre verleden zijn. Daarmee levert het een internationaal belangrijke bijdrage aan de methodologie van het moderne landschapsarcheologische onderzoek.